

Comprehensive Questions for Module-7: Strength and Failure theories

1. What are various failure theories?

Self-Assessment Questions

Indicate whether statements 1 to 6 are true or false.

1. According to the maximum stress criterion lamina failure is determined by the absolute maximum component of stress in the lamina.
(A) true
(B) false
2. The maximum stress and maximum strain criteria will predict the same failure loads.
(A) true
(B) false
3. A hybrid stress criterion is used for composites containing more than one fibre type (i.e. a hybrid composite).
(A) true
(B) false
4. An interactive stress criterion cannot directly predict the mode of failure.
(A) true
(B) false
5. An interactive criterion will always predict failure stresses different to those predicted by the maximum stress criterion.
(A) true
(B) false
6. When predicting the final failure of a laminate it is necessary to know the failure mode of individual plies.
(A) true
(B) false

For each of the statements of questions 7 and 8, one or more of the completions given are correct. Mark the correct completions.

7. Maximum strain criterion
 - (A) can be obtained from the maximum stress criterion by dividing each term by an appropriate stiffness,
 - (B) comprises five sub-criteria,
 - (C) cannot predict failure stresses,
 - (D) will give the same prediction as the maximum stress criterion for a lamina in a uniaxial stress state when the stress is parallel to the fibres,
 - (E) gives a better prediction than the maximum stress criterion when the stress-strain relation shows significant nonlinearity.
8. Tsai-Hill criterion
 - (A) is only applicable if the direct stresses are tensile,

- (B) cannot predict the mode of failure,
- (C) gives better prediction than does a limit criterion for a unidirectional lamina when the fibres are not aligned with the applied stress,
- (D) cannot be used to predict the final failure of a laminate,
- (E) cannot be used to obtain a reserve factor.

Each of the sentences in questions 9 to 15 consists of an assertion followed by a reason.

Answer:

- (A) if both assertion and reason are true statements and the reason is a correct explanation of the assertion,
- (B) if both assertion and reason are true statements but the reason is not a true explanation of the assertion,
- (C) if the assertion is true but the reason is a false statement,
- (D) if the assertion is false but the reason is a true statement,
- (E) if both the assertion and reason are false statements.

9. A lamina is deemed to have failed when the fibres fracture because the fibres carry the highest stresses.
10. When predicting the failure of an off-axis lamina it is necessary to calculate the stresses in the principal directions because these stresses are always greater than the applied stresses.
11. The maximum stress criterion will always predict failure in tension because the longitudinal tensile strength of a unidirectional ply is greater than the corresponding compressive strength.
12. The Tsai-Hill criterion gives a more accurate prediction for off-axis loading because it does not predict the mode of failure.
13. Initial failure of a cross-ply laminate can only be predicted by the Tsai-Hill criterion because it corresponds to transverse ply cracking.
14. Prediction of laminate failure requires an iterative approach because ply stiffnesses are modified as failures occur.
15. Classical Laminate Theory cannot predict failure of finite width laminates because it ignores the existence of through-thickness stresses.

Answers

Problems

Self-assessment

1 - B; 2 - B; 3 - B; 4 - A; 5 - B; 6 - A; 7 - B, D, E; 8 - B, C; 9 - B; 10 - C; 11 - D; 12 - B; 13 - D; 14 - A; 15 - A.